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Submission date: 17-May-2019 03:01PM (UTC+0700)

Submission ID: 1102517093

File name: system_using_voice_recognition_and_fingerprint_on_smartphone.pdf (286.1K)

Word count: 2746

Character count: 14751

Smart Mobile Attendance System Using Voice Recognition and Fingerprint on Smartphone

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Abstract—The attendance system has been known for a long time, ranging from manual system to automated and complicated system such as attendance system using biometrics. All those attendance system have several weakness, especially to control of employees who work outside the office. In this paper we introduced a attendance system that can be used to record the attendance of employees who are duty outside the building. Our system is also integrated with payroll system that make accounting department can easily calculate and report the salary included the overtime cost. The proposed attendance system used smartphone to verify the employee. The system provide two options for doing verification, such as fingerprint and voice recognition. In this research, we find that fingerprint verification has false positive 95% and the false negative of voice recognition is 5.88%.

I. INTRODUCTION

Along with the growing number of smartphone users, the number of applications available on smartphones also increased. But there has been no application for attendance system on a smartphone that is easy to use and integrated with the management attendance system tool controlled by the personnel department. On the other hand, there are many disadvantage in attendance systems currently available such as a long queuing in front of the attendance machine at the time come to work and after work, monitoring employees who work out side of office, the organization has to spend on the device as well as badges, and difficult to maintain and repair the devices.

Some companies also need to monitor their employee who working outside the office or out of town. In order to calculate the employee's salary who work outside the office, the personnel and finance department need to know how many hours the employee come to work. The problem is there is no tool that can monitor working hour of employee outside the office. Most of the time the employee just feel the sheet of paper to write down name and time by the self without any control or monitor. Therefore an automatic attendance system using voice recognition and fingerprint on smartphone would provide the new solution.

In this paper, we developed attendance system that integrated with system payroll so that overtime can be calculated automatically, while also providing feature to monitoring

employee who working out of office. Our attendance system also can generate reports and monitor the employee who late and leave work early. We developed an application that can be installed on smartphone for client and an application that can be installed on PC for admin. The information of date, time, unique number of android system, smartphone number, and GPS (Global Position System) coordinate will be sent by smart phone to database server along with the fingerprint of employee. The employee must login to their account before sending the information. The process of login or authentication process can be done either by voice recognition or by fingerprint.

We used minutiae and texture features algorithm for matching the fingerprint in authentication process [1]. The minutiae features are ridge ending, bifurcation, and short ridge. The number of these minutiae features are unique for each person. In fingerprint matching algorithm for authentication process, we compared the number of minutiae features of employee. We took the fingerprints of employee who participate in our research and we save the number of minutiae features in a server as a template.

At this time not all smartphones have the fingerprint sensor, therefore we also developed voice recognition technique for authentication process. The algorithm for matching voice is random alphabet. We record 26 alphabet characters for every person who has participated as a template and we save them in server. The five characters will be generated randomly at the time the employee do the authentication process. They have to read clearly the five characters on their smartphone. If the frequency match with the template then the employee pass authentication process.

II. RELATED WORKS

A number of research have been done to develop attendance system such as Shoewu, [3], Rao [4], Josphineleela [5], Masalha [6], and Ashok [7].

Shoewu et. al [3] developed an attendance management system to manage student attendance using biometrics. Student have to put the fingerprint on the fingerprint sensor and the student's matriculation number were sent to database. At the end of semester the reports can be generated to know



Fig. 1. System Architecture

the percentage of student attendance. They have developed a fingerprint attendance system included its hardware and software components. The result is manual attendance system took 17.83 second for 80 student compare to 3.79 second for fingerprint attendance system.

Rao and Satoa [4] developed automatic attendance system using fingerprint verification technique which done by extraction of minutiae technique. The study was conducted using a quantitative approach by designing a questionnaire as the data collection instrument [10] based on fingerprint matching biometric technologies. The process was divided 3 phases; Phase 1: Fingerprint scanning and registration, Phase 2: Fingerprint recognition or authentication, and Phase 3: Attendance update.

In Josphineleela [5], a novel fingerprint reconstruction algorithm is proposed to reconstruct the phase image, which is then converted into the grayscale image. Algorithm consist several stages: Preprocessing, minutiae extraction, Fingerprint reconstruction, and Fingerprint recognition.

Masalha and Hirzallah [6] introduced a student attendance system using QR Code. The QR Code is a type of two dimensional bar code that has square shape with black square dot on white background. The lecturer has to generate an encrypted QR Code and student have to scan the QR Code (Quick Response Code) to do the attendance process. Student can scan the QR Code by their own devices such as cellular phone, smart phone, tablet or any devices that has a camera.

Ak and Begum [7] compared three fingerprint matching algorithms by conducting the election using novel EVM (Electronic Voting Machine). The three fingerprint matching was direct matching, minutiae matching, and matching based on ratio of distance. The authors measure matching accuracy and time then they select the best algorithm for EVM. They conclude that the minutiae matching is better than direct matching and ratio of distance in terms of memory and time.

III. PROPOSED DESIGN

In this research, we used android smartphones that have fingerprint scanner, because attendance system that we developed used biometric methods to identification users, in this

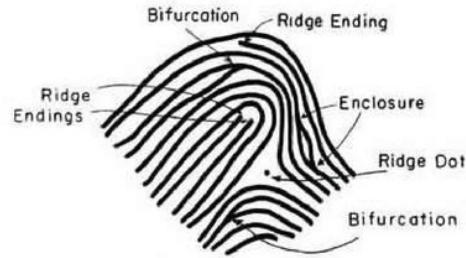


Fig. 2. Minutia of ridge ending, bifurcation, enclosure and ridge dot

research we used fingerprint and voice. So we have to take the fingerprint and voice of 100 volunteers (participants) as well as personal data for identification test and attendance system itself. Then we start developed algorithm fingerprint matching and voice matching. Once this is done, then the research can be continued with tested applications. The system architecture can be seen in figure 1 that has five components: smartphone, parser, server, desktop and printer. The users or employee can do attendance from their own smartphone after they download and install our application and register their smartphone to administrator. When they do attendance, the application will send the information such as GPS coordinate, date and time, unique number of android operating system and the fingerprint or voice for authentication to parser. If the authentication process succes, then all those information will be saved in the application server. The administrator can process the information to make report or to calculate the overtime.

A. Fingerprint Matching Based on Minutiae and Texture Features

In our system the fingerprint identification and matching based on minutiae and texture features. This work has been done and discussed in [8] and [9]. Generally, fingerprint matching algorithm to verify the identity of a person is based on lower level features that matching of finger ridge patterns called minutiae. Minutia matching is the most popular approach to fingerprint identification and verification.

Fingerprint matching usually consist of two procedures: minutia extraction and minutia matching [10]. The performance mostly depends on the accuracy of the minutia extraction procedure. Usually, the most important features to match are ridge ending and ridge bifurcation as we can see in figure 2 taken from [11]. The steps of fingerprint matching in our attendance system follow the diagram in figure 3.

In our work we used algorithm fingerprint matching based on minutiae and texture features that have been introduced by Anil [1]. Firstly, we calculated the minutiae point on the templates and input used method [3] [2]. Using this method will generated two input, first is a set of minutiae points, each characterized by its spatial position and orientation in the fingerprint image, second is local ridge information in the

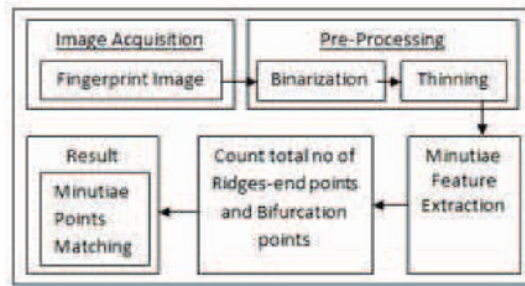


Fig. 3. Algorithm of fingerprint matching

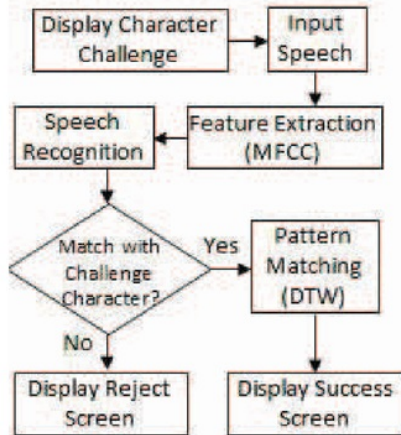


Fig. 4. Algorithm of voice matching

3 vicinity of each minutiae point. The two sets of minutiae points are then matched using a point matching algorithm. The detail algorithm can be seen in [1]

B. Voice Recognition

Voice Recognition is a technology that uses voice, phrases, and words spoken by someone and transformed into electronic signals, then the electronic signal is converted into a voiceprint or spectrogram. The next voiceprint or spectrogram is stored as a table in the form of sequence of numbers in which each dominant frequency in each segment expressed as a binary number. From here we already have a sound template that can be used to match on the authentication process.

Figure 4 shows the algorithm of voice matching that we used in our work. The algorithm's voice recognition will be the measurement of the percentage of compatibility or matching between the template voice are stored in a database on a server with 100 sample other voices. It is done to obtain more accurate threshold percentage that will be used to determine whether the voice data was regarded as a person who has voice that is stored as a template in the database or not. In addition, this is done to determine whether the algorithm

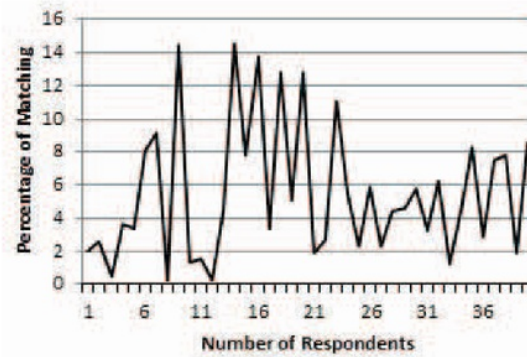


Fig. 5. Percentage of false positive fingerprint matching

voice recognition is used is relatively safe and difficult to be penetrated using a recorded voice or not [12]. The process of analysis of the algorithm voice the recognition can be seen in figure 4.

The voice recognition algorithm is divided to several process as follows:

- 1) The system will generate random characters to be used as a challenge to the user.
- 2) Random character will be displayed on the screen and the user must immediately pronounce the characters in a certain time period.
- 3) Upon completion character is spoken, then the incoming voice will be identified.
- 4) If the character is pronounced the same as the characters that are generated by the previous system, the stage will be continued on the voice feature matching template in the database, otherwise it returns to the login screen.
- 5) The process of matching the voice with the template feature is done, if the features match with the template, it will display the home screen, otherwise it will go back to the login screen.
- 6) The matching process is done with relation one-to-one, where the android device id is used as a data identifier voice templates on the server.

IV. RESULT AND DISCUSSION

Our attendance system has two options to verify the identity of user such as fingerprint and voice. We took 40 students as respondents to proof that the fingerprint matching algorithm that we developed can be work properly. Each respondent perform fingerprint authentication on a account that was not belong to respondent as many as 20 times. The result can be seen in figure 5. In the figure show that 95% respondents can succes to login to the account and 5% of respondents could not login the account.

The steps to test voice verification as follow. Firstly, we took 100 samples of voice for each person, each person has to speak the 26 characters of alphabetic. Then we used these voice as a template to be matched in the authentication process. We also



Fig. 6. Screenshot of identification using voice recognition



Fig. 7. Screenshot of matched identification

made an experiment Here are the results of experiments using voice of other people. The goal is to get the percentage value of how much the voices of different people who should not be considered matching the voice but it is considered matching by the system or in other word, we calculate the false negative. We calculated it used following formula:

$$\frac{\text{number of matching invalid voice}}{\text{Total sampling}} \times 100\%$$

From the test results obtained percentage of invalid voice that considered valid is 5.88%.

Figure 6 show the screenshot on the smartphone. The user or employee has to tab record button and speak the character L W X E D U Q A in order to do attendance. If the voice match with the template in the data server then the user will success to do attendance as showed in figure 7. Every time the employee want to do attendance, the character will be changed randomly.

V. CONCLUSION

Attendance system in this study using fingerprint and voice as a method of identifying and recording the coordinates GPS to ensure the user's location when do attendance. This

will prevent the user manipulation of the attendance system, especially the user or employee who work outside the office. The attendance system use smartphone or mobile devices can prevent the queue as when using other attendance system, especially at peak hours (at the time come to office and out of office) where the number of users and the number of devices attendance system has a ratio that is not balanced. With the attendance system based smartphone or mobile device, each person have android-based mobile device can be mounted absences application so no need to queue in electronic attendance device or the manual system provided by the company.

ACKNOWLEDGMENT

The authors would like to thank Directorate General of Higher Education (DIKTI), Republic of Indonesia for their support in making this research possible. This research was supported by Competitive Research Grant scheme 2016.

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